Phonetic and phonological distinctions in sign languages

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1. Introduction

In designing a phonological model we do not, as in the case of spoken language, have the advantage of being able to rely on a long tradition of proposals for feature sets and higher constructs. If linguistics is a young (and, some would say, immature) discipline, than sign linguistics has just been born. It essentially started in 1960 with the publication of Stokoe (1960), anticipated by earlier work that recognized the linguistic, communicative status of signing (for example Tervoort 1953). As might be expected from explorative proposals for feature sets, there has been a strong focus on the great richness of phonetic diversity of signs, and much less on phonological distinctiveness. As a consequence, most proposals for feature sets involve rather large sets of features, minutely encoding many phonetic details, and giving the impression that the feature structure of signed languages is much richer than that of spoken languages.

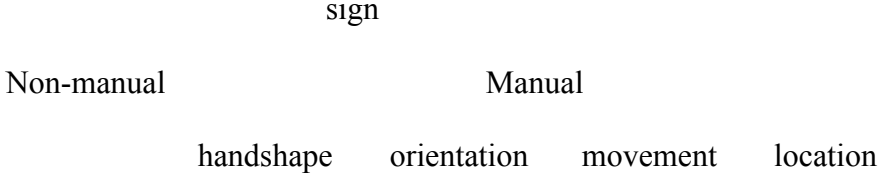
Having said this, we do not wish to underestimate the enormous advances that have been made in the short period of 40 years by a relatively small group of linguists. In the early seventies we find foundational work in Klima and Bellugi (1973), reflecting the research of a group of influential researchers. In addition, several very detailed dissertations on the phonology of **American Sign Language** (ASL) appeared around that time, and throughout the eighties (for example Friedman 1976, Mandel 1981, Battison 1978, Sandler 1989; for overviews see Wilbur 1987).

In this article, we will first discuss some of the earlier systems for the micro-structure, i.e. the featural analysis of signs (section 2). Then, in section 3, we discuss some of the more recent developments which relate more to the macro-structure of signs. We present the results of this overview in terms of our own understanding of the macrostructure, i.e. the Leiden model. We make a number of comparative remarks about spoken and signed language in section 4. In section 5, we discuss a number of issues that arise in the study of sign phonology and phonetics. Section 6 contains our conclusions.

2. Micro-structure

Since the pioneering work of Stokoe (1960), signs are said to be composed of **non-manual** properties and **manual** properties. The former *can* play a role at the level of lexical distinctions, but seem more active at the post-lexical level.[1] Here, we have no proposals concerning non-manual categorization of phonological elements. Manual properties involve a characterization of the **handshape**, the **movement** of the hand and a **location** (where the action takes place). Battison (1978) added **orientation** (of the hand) as a fourth manual property. Each unit in (25) can be instantiated by a finite set of values, features, or elements:

(1)



[what should follow here is a discussion of feature systems.]

3. Macrostructure

Stokoe put forward the idea that the difference between a sign (for example meaning CAT) and the English word *cat*, was that the former was essentially a **simultaneous event**, whereas the latter had a temporal organization. Thus, the basic elements of a sign (*movement*, *handshape*, *location*, etc.), which he called **cheremes** (and later phonemes) were noticed by Stokoe to be linearly *un*ordered, whereas the phonemes of speech are linearly sequenced. Note, however, that the structure in (1) seems to have formal properties that make it look like the structure of single phonemes in spoken language. After all, the class units that make up a phoneme are not linearly ordered either. Hence, if one would compare (1) to single phonemes it would seem that the difference between spoken and signed languages is not whether or not use is made of linear order, but rather that **monomorphemic words** in sign language appear to be **monosegmental** (van der Hulst 1995a), whereas words in spoken languages (except for some closed class words, for example certain prepositions or pronouns) are typically polysegmental. We will return to this issue below. First let us look at some more history (Corina and Sandler 1993).

After Stokoe's groundbreaking work, later researchers (for example Newkirk 1981, Suppala and Newport 1978, Liddell and Johnson 1984) felt that it was necessary to be able to make reference to the beginning and end point of the movement of signs, for example for morphological inflectional purposes, or to express assimilations involving a

[1] Non-manual properties at the post-lexical level encode distinctions that, in spoken languages, are often encoded in terms of **intonational tones** (**boundary tones**, **pitch accents**). The functional correspondence between *non-manual* and *laryngeal* is supported here by a formal correspondence in terms of their place in the phonemic structure in our own model.

switch in the beginning and end point of the movement (see Sandler 1989, van der Hulst 1993 for a discussion of the arguments). Without *formally recognizing* the beginning and end point in the linguistic representation it would be impossible to formulate rules that refer to these entities. These considerations led to the adoption of some kind of **skeleton** to which the other units of the sign associate in an **autosegmental** fashion (as explicitly proposed in Sandler 1986). Most researchers (Liddell and Johnson 1984, 1989, Sandler 1989, 1993, Perlmutter 1992, Brentari 1999) proposed a skeleton that not only represented the **initial location** and **final location**, but also an **intermediary movement**:

(26) L M L

Several researchers have assigned a central perceptual status to the movement unit (see Perlmutter 1992, Corina and Sandler 1993, Sandler 1993, Brentari 1999 for relevant discussions) and it then seemed obvious to refer to the LML sequences as analogous to a CVC-syllable (see Chinchor 1979, Coulter 1982). Following up on these earlier ideas, Perlmutter (1992) explicitly compares the M to the vowel in speech and also adds a **moraic layer** to the representation.

The model that was proposed in van der Hulst (1993), however, denies movement as a unit on the skeleton, following several other researchers (for example Stack 1988, Hayes 1993, Wilbur 1993), and replaces the **LML-skeleton** by a bipositional **XX-skeleton**. Having reduced the skeleton to two positions, we could, as we suggest here, interpret these positions as the syllabic onset – rhyme (offset) structure of the sign, assuming here without argument that the second position in the skeleton is the most salient one (see Brentari 1999, van der Kooij, in prep. on this claim).

Before we turn to the question as to how we can understand the **autosegmental relation** between the skeleton (with or without a movement unit) and the primes that specify the 'content' of signs, we have to go into a more detail concerning the required set of primes. As mentioned, we will limit myself to the manual part of (25). What follows is discussed in more detail in Crasborn, van der Hulst and van der Kooij, in prep., Crasborn, in prep, and van der Kooij, in prep.).

place

In order to indicate where a movement starts and where it ends, we need to assign place specifications to the skeletal positions. However, these specifications (whatever they are) do not exhaust the specification of place, since it appears that each individual movements (limiting ourselves to monomorphemic signs) is restricted to occur within a certain area, for example in front of the chest, or in front of the upper or lower part of the face, or along side the lower arm of the non-articulating hand, etc. Sandler (1986) therefore proposes to distinguish between two notions of place. Here we refer to the restricted area as **location** (for example *chest*, *head*, *arm*, etc) and to the specific beginning and end within these areas as **settings** (for example high, low etc.). The specification for location takes scope over the whole sign, while the setting values bear on the initial and final skeletal position. Here, we have no proposal to make for the categorization of place, which would hopefully develop along the lines of the schema in (19) (see 27 below). We will return to setting values below.

Handshape and orientation

On the basis of joined behavior in assimilation processes, Sandler (1986, 1989) proposed that *handshape* and *orientation* (of the hand) form a class that we will here call **articulator** (following Brentari 1998). With reference to *handshape*, as with *place*, we also find properties that remain constant throughout the signs, as well as properties that can change. One constant property is **finger selection** (*fingsel*). *Fingsel* refers to the fingers that are 'foregrounded' (selected), as opposed to the 'backgrounded' (non-selected) (see Mandel 1981: 81-84). Mostly, foregrounded fingers are the **extended fingers**, while backgrounded fingers are folded, and for our present purposes we will simply adopt this simplification (see Sandler 1989, Kooij, in prep. for a detailed discussion). *Fingsel* involves three finer class nodes. Firstly, there is a node (*fing*) that bears on the four fingers, allowing the extension of [one] or [all] fingers.[2] Secondly, we specify the **side** of the hand in case less than all the fingers are selected as [radial] or [ulnar] (thumb and pinky side, respectively). Thirdly, we can specify the selection of the **thumb** separately as [in] or [out]. During the articulation of a (monomorphemic) sign, the specifications of all three *fingsel* nodes are constant. *Fingsel* does not fully determine the *handshape*, however. The selected fingers occur in a certain **configuration** (*config*). *Config* also has three finer class nodes. Firstly, we consider here the bending of the fingers in terms of **flexion** (*flex*) of the finger joints. We distinguish between the joints that connect the fingers to the hand ([base]), and the two 'higher' finger joints, jointly ([non-base]). A second dimension of *config* is **aperture**, that is an [open] – [close] relationship between the thumb and the selected fingers. Thirdly, selected fingers can be **spread** [open] or hold against each other [close]. Of these three nodes, flex must remain constant, while both aperture and spreading can change.[3]

Turning now to *orientation*, it turns out that the value for this node may change, that is a sign can involve a rotation of the underarm such that, for example, the palm faces the signer at the beginning while the back of the hand faces her at the end of the sign. we will refer to the values of orientation as [neutral] and [nonneutral]. The neutral value specifies the 'natural' (that is most 'comfortable') position of the underarm wherever the hand is placed.[4]

With this much detail, we can state precisely what remains constant and what may vary in the articulation of a monomorphemic sign. *Place*, *fingersel*, and *flex* are **constant**. Dynamic aspects of the manual part of the sign may involve *setting*, *orientation*, *aperture*, and perhaps (but very marginally) *spreading*. The following diagram summarizes the categorization the sign in class nodes, and of the class nodes in phonetic categories. Italicized nodes may involve a potentially dynamic specification, which we discuss below:[5]

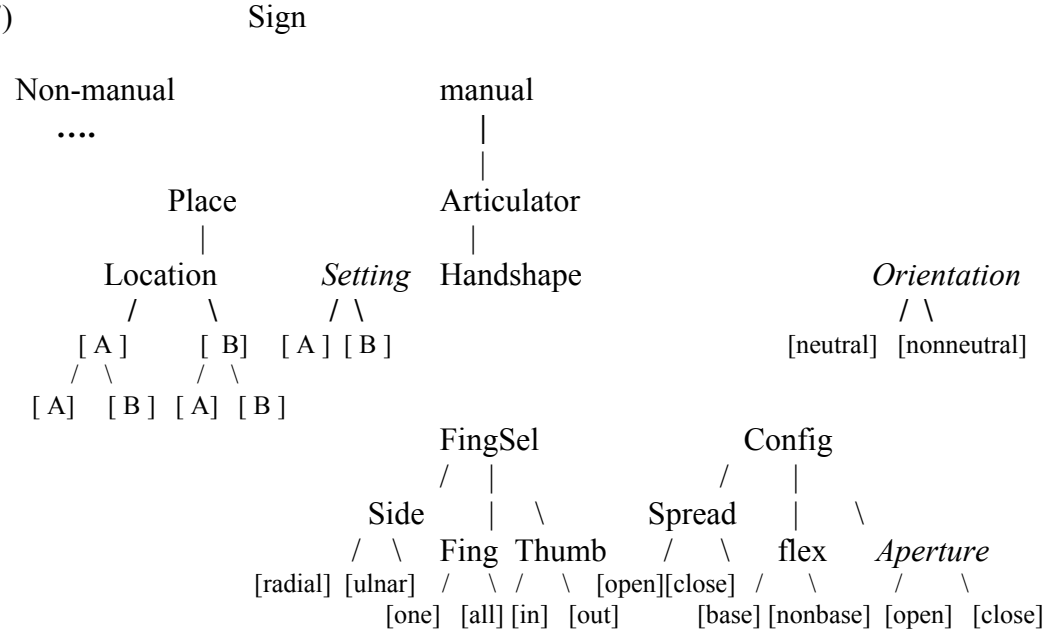
[2] Henceforth, we use square brackets to indicate relevant phonetic categories. An interpretation in terms of elements follows below.

[3] Dynamic spreading/non-spreading can be found in the sign for SCISSORS (in ASL and many other sign languages). This dynamic aspect may simply be an iconic trait of signs in this particular semantic field.

[4] Perhaps, orientation changes should also include flexion and sideward movements of the wrist. It is also possible that such changes are really (reduced) path movements.

[5] we have not discussed here the distinction between one- and two-handed signs. In two-handed signs, the two hands cannot operate independently. Both hands are either copies of each other, or one of the hands is the place of articulation for the other; see van der Hulst (1996b).

(27)



Although, we have not motivated that here, we see that all nodes within the *handshape* unit are categorized in terms of two polar categories, that is no further division seems necessary. At this juncture, (27), with all its distinctions, represents our best hypothesis (and partly: guess) with respect to what the phonologically relevant categories for sign language are. If we now equate each category (that results from a binary split of the relevant phonetic space) with an element, this implies that no combination (plus head – dependency) of elements is required in most cases. We suspect that things will be more complicated for *place* and we know that in the case of the node *Fing* we encounter a more complex situation, since, as said, there are in fact more options for finger selection than just [one] or [all]. Handshapes can also have two or three foregrounded fingers. Hence the elements corresponding to [one] and [all] can enter into combinations (and dependency relations). We will not, however, discuss, these combinations, and their interpretation here (see van der Hulst 1995c, 1996a, van der Kooij, in prep.). The categorization of each phonetic subspace into polar categories is precisely what we expect given the principles of RcvP. That in most cases the division of the phonetic space is limited to two categories indicates, perhaps, that a more detailed parsing is more likely less likely to occur in more 'refined' classes.

So how do we name the elements? Our first inclination is to simply extend the use of the C and V. It does not seem sensible, however, to use these labels, which betray their spoken language origin and bias. Rather, we might directly make use of a head-dependent labeling. In all cases, we assume, that one of the elements is unmarked and thus a head (see Crasborn, van der Hulst and van der Kooij, in prep., van der Kooij, in prep. for further discussion). The head choice is phonetically manifested as the more salient phonetic category. Thus, we would expect that the categories [all], [out], and [open] are heads. The choice seems less clear for the nodes *side* and *flex*.

Turning from elements to structure, we note that, in the spirit of RcvP, the structure in (27) is headed at every levels. Given the (perceptual) centrality of the articulator, we have represented *non-manual* and *place* as dependents. Within place,

location is taken to be the head, because it encodes the major place distinctions, with *setting* making subdistinctions. Within *handshape*, we take *fingsel* to be the head, since *config* clearly modifies the selected fingers, and within each if these nodes we have proposed to regard the property that is crucially defining the handshape as the head, that is *fing* and *flex*. Notice that, if this is correct, **invariance** (that is being constant across the sign) is a diagnostic property of heads. we realize that all these decisions need further motivation and we remind the reader of the tentative nature of this proposal.

Let us now turn the dynamic aspects. There appear to be three types of movement:

(28) *Types of movement*
a. Path movement
b. **Aperture change**
c. **Orientation change**

Path movement is movement of the articulator as a whole. We represent it in terms of *setting* values under the *place* node.

'Movement' of *orientation* is called orientation change, which is brought about by rotation of the underarm. Finally, movement in the *aperture* node is called aperture change.[6] Orientation change and aperture change have also been called **local changes** as opposed the **global path movement**.

Each of these dynamic events may occur by itself and be the only movement of the sign. Path movement may also be combined with either aperture or orientation change. In that case the *global* path movement is called **primary**, while the other local movement is called **secondary**. The beginning and end state of primary and secondary movements must coincide (as discussed in Perlmutter 1992).

The typology of movements for *orientation* and *aperture* is simple. In fact, for *orientation*, as said, we need an element that denotes the [neutral] state and one that represents the [non-neutral] state (but see fn. 24). The beginning state of the sign is either neutral or non-neutral, while the end state (if there is an orientation change) is the opposite. For *aperture* we have the choices [open] and [close]. Again the beginning state can be either, while the end state (if there is an aperture change) is the opposite. A path movement can be specified in terms of polar settings on the three cubic axes (vertical, horizontal and away from the signer), the 'movement' (if present) being the transition between a beginning and an end state:[7]

(29) Orientation [neutral] - [non-neutral]
SelFing [open] – [close]
Config [high] – [low], [ipsi] – [contra], [distant] – [proximate][8]

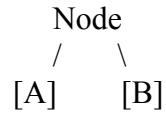
[6] Aperture change is also sometimes subsumed under **hand-internal change**, another type of hand-internal change being **wiggling**, which we have left out of consideration here.

[7] In some cases, however, the movement seems too complex to be understood as simple **interpolation** between the settings assumed here (for example involving diagonal, curved, circular or zigzag paths). This probably means that the categorization of the place space is more complex than what we have assumed here. It is also possible that some of these more complex paths are due to iconicity (see section 4.3).

[8] [ipsi] means 'side of the articulating hand'; [contra] refers to the opposite side. Distant-proximate is probably the same as no-contact – contact (for example with the body).

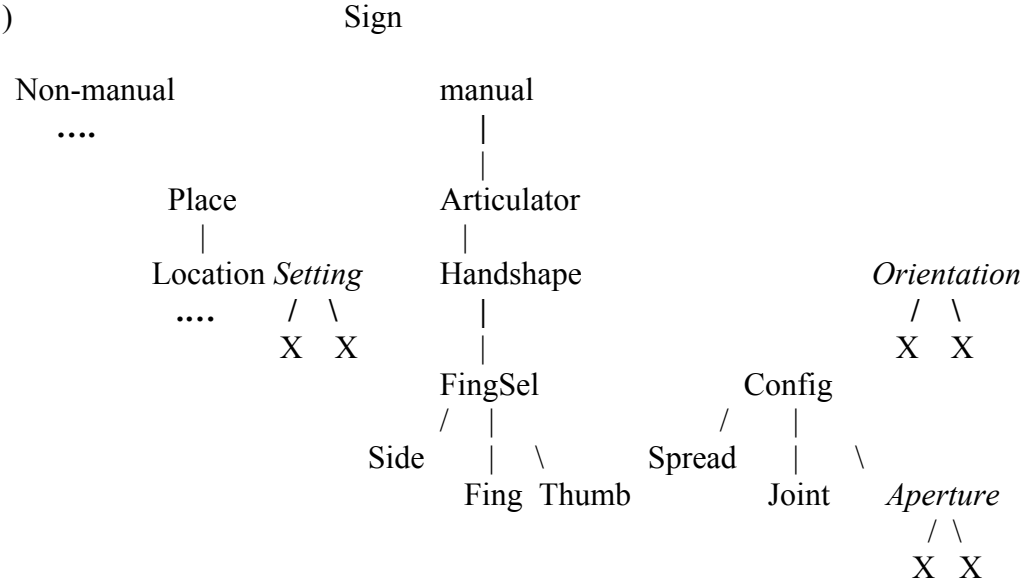
With these features we can represent movements as branching structures:

(30)



The variable 'Node' in (30) can be *setting*, *orientation* or *aperture*. So where do we locate the elements for [A] and [B] in the formal representation? The obvious locus for these elements is the X-positions on the skeleton. However, since we can have branching feature specifications for *setting*, *orientation* and *aperture* it would seem that we really have three skeletons:

(31)



The understanding here is that the initial and final X (that is onset and rhyme) in each case is synchronized in the phonetic implementation of the sign. By locating the primes that determine a dynamic event on the 'onset' and 'rhyme' slots we derive that their ordering is crucial because syllabic constituents *are* linearly ordered. If the branching structures were a proper part of the content specification of the sign, we would have to introduce linear order (not needed so far) at that level. It is more satisfying that we can keep the content structure free from linear order, and introduce linear order not until the syllabic organization starts. A consequence of the proposal here is that, in some sense, a sign with two movements is **bisyllabic**, the syllables being simultaneous. This conclusion converges with ideas expressed in Wilbur (1993) and Brentari (1998).

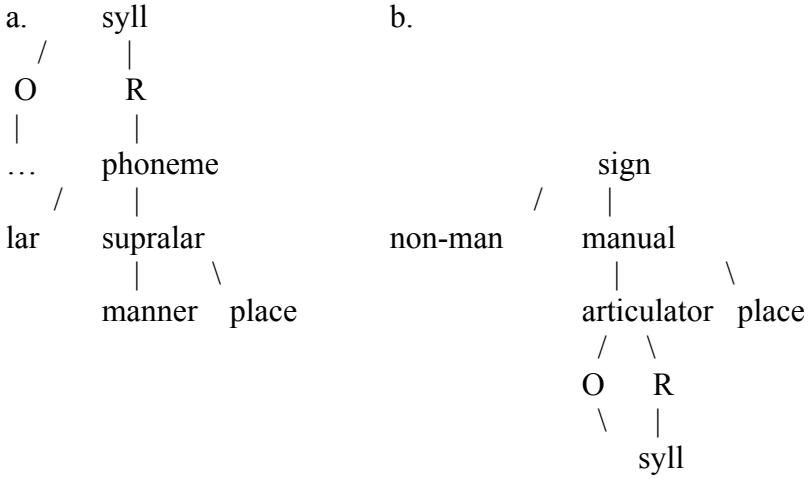
With respect to branching setting there may actually be an interesting alternative. Since *fing* is the ultimate head of the articulator, we might also decide to make the setting values dependent on this node. The conceptual advantage of that move would be that all movement would then be formally *movement of the articulator*. Below, we will see that we can then also achieve a unified notion of *manner of articulation* for both spoken and sign structure.

4. A comparison between spoken and signed language[9]

4.1 The articulator and manner

An important difference between signing and speech is that in speech the articulator does not have distinctive properties. The speech articulator is predictable from the place of articulation. If the place is labial, the articulation is the lower lip or lower teeth (the difference is not distinctive)[10]. When the place is within the oral cavity, the articulator is the tongue, the front part if the place is dental/alveolar, the back part if the place is velar[11] and the lower part if the place is phargyngeal. This is why we do not find an articulator node in the representation of the phoneme of spoken languages, or why phonologists have come to use articulator and place terminology almost interchangeably. In sign languages, as we have seen, the articulator is far from redundant. On the contrary, it can have a wide variety of properties.[12] Thus, where the phoneme of spoken language has *manner* (that is movement of the articulator) as its head, we find the *articulator* in head position in the structure of signs. This does not mean that sign language has no *manner*. In fact, for sign language, we can look upon movement (of the articulator) as manner since, as in speech, movement *is*, in fact, movement of the articulator with respect to a place.[13] The difference between manner in speech and in sign seems to be that while in the former, manner is partly in the content and partly in the syllabic structure, manner in sign is wholly in the syllabic structure (I have lined up the parallel parts of the structures):

(32)



[9] See Studdert-Kennedy and Lane (1980) for an intriguing comparison making some of the same points that we make here.

[10] The difference between bilabial and labiodental fricatives can be understood as a difference in manner, that is stridency.

[11] The difference between velar and uvular, we assume, is one of complex or double articulation. Palatals also involve double articulation.

[12] It follows that sign language phonologies may, for that reason, have more phonologically relevant phonetic distinctions than spoken language phonologies.

[13] One might argue that an additional difference between sign and speech articulators is that signing has two articulators, that is two hands. However, even though a distinction between one-handed and two-handed signs can be distinctive, the choice of which hand to use in one-handed signs cannot be used distinctvely. In this sense, then, the mind recognizes only one articulator.

The extra architecture that the sign phoneme has, apparently lies the structure of the articulator which, in fact, recapitulates the general X-bar template three times. In the next section, we will explore the notions of segment and syllable in both modalities in greater detail.

4.2. The segment and the syllable

Sign linguist have been investing a lot of energy in asking whether the sign is a syllable or a segment (see Wilbur 1993, Corina and Sandler 1993, van der Hulst 1995, Brentari 1999). Several researchers, indeed, have suggested that the morphological simple sign is like a syllable (for example Chinchor 1978, Coulter 1982, Perlmutter 1992).[14] we have here arrived at the conclusion that this is, in fact, correct, and the two structures in (32) illustrate this. Sign language syllables are, in a sense, all 'CV' (that is simple OR) syllables. In both cases, the total structure comprises both the syllabic and the phonemic structure. The structure in (32b), however, seems to imply that in the structure of signs, certain portions of the phonemic class node structure dominate the syllabic structure. This is not just a consequence of designing the diagram. In sign language, most elements (except potentially those for *setting*, *orientation* and *aperture*) have scope over the whole sign. In the syllabic organization of spoken language, however, the syllabic onset – rhyme division takes precedence over the distribution of elements, that, as a consequence, have scope over the onset or rhyme only. In spoken language, the syllable is **suprasegmental**, while in signed language the segment is **suprasyllabic**.

Let us now, subsequently, try to understand why the speech syllable is primarily a syntagmatic sequencing syllabic structure and secondarily, per syllabic position a paradigmatic structure involving features or elements, while the sign syllable (in the spirit of Stokoe 1960 stated) seems primarily a paradigmatic featural structure that spreads out over a secondary sequencing structure. we wish to suggest that this difference is a true modality effect.

I believe that the reason for the difference lies in a crucial difference between **auditory** and **visual perception**. Not being an expert in perception, we nonetheless venture to suggest that the perception of signs is more 'instantaneous' than the perception of auditory speech input. The latter reaches the ear sequentially, in temporal stages. If this is so it does not come as a surprise that the temporal, syntagmatic organization of speech is perceptually salient and takes precedence over the paradigmatic organization. Turning to the sign syllable, Stokoe was right in saying (and seeing) that the notion of time-span is perceptually less important in the visual signal. Consequently, it does not seem plausible to assume that the structure of signs would depend foremost on separating the beginning and end phase of signs. Rather, the paradigmatic structure takes precedence over the syllabic, syntagmatic division in onset and offset (rhyme). The temporal structure of signs comes in as secondary structure, giving rise to the bipositional skeleton as a kind of afterthought.

[14] Often suggesting that the syllable = morpheme = word relationship in sign is like that in Chinese languages.

We can understand the different in terms of Goldsmith's (1975) notions of **vertical** and **horizontal slicing** of the signal:

(33)

Speech	Signing
vertical (syntagmatic)	horizontal (paradigmatic)
|	|
horizontal (paradigmatic)	vertical (syntagmatic)

I now wish to point to a difference between monomorphemic words in spoken languages and in signed languages which involves the **monosyllabicity** of signed words, as opposed to the typical **polysyllabicity** of spoken words.

In spoken languages, the need for going beyond simple CV words lies in wanting to have a sufficiently large number of semantic distinctions in the lexicon, without having to go into morphology. Thus spoken languages either elaborate the syllabic structure, allowing branching onsets and rhyme, and/or utilize polysyllabic units like feet and prosodic words. A third option lies in invoking a complex tone system in terms of rhymal laryngeal distinctions.

We have seen that the notions of **branching onset** or **branching rhyme** do not apply to sign languages. Also it seems that most basic words are, syntagmatically, monosyllabic[15]. One does not typically encounter the additional layer of foot structure. we would like to suggest that this is so because of the availability, in sign, of the articulator (which is distinctively missing in speech). we noted that the articulator in signed languages, unlike that in spoken language, is a richly compositional unit. This means that lexical elaboration of the formational possibilities can easily be found in combining the extensive set of *handshapes* every combination of *orientation*, *place* and all the types of *movement*. We might add several other ways in which the compositional world of signs is richer than that of speech units. Firstly, the type of manner (that is movement) that is allowed in speech toward the constriction target is always predictable, that is it is the shortest path. In sign, however, we note that movement of the whole hand (between an initial and a final state) can be performed in a variety of ways (straight, arced, circular etc.). It seems to be the case that such differences are indeed used contrastively.[16] Secondly, sign language uses *iconicity* as a means of differentiating signs. From a functional point of view, then, there is simply less reason to complicate the structure of lexical entries by allowing for combinations of syllables into feet and beyond. The phonetic space that is available to the manual aspect of signing is more elaborate than the supralaryngeal aspects in speech and this, combined with the other extra means mentioned, apparently, allows a rich enough inventory of monomorphemic words (or morphemes).[17]

[15] Recall that signs with two movements can be regarded as being polysyllabic.

[16] we say this, realizing that we do not really have a well-developed set of really constrative possibilities in any sign language.

[17] Sign languages do not make abundant use of non-manual distinctions at the lexical level. In this sense (and to the extent that we can compare *non-manual* to *laryngeal*), sign languages are quite unlike Chinese languages.

5. Some further issues in the sign phonology

5.1 Evidence for compositionality

I have discussed a richly articulated compositional structure for signs. But what evidence do we have that signs, in fact, have a phonological **compositionality**? The mere fact that we are capable of designing a sensible structure, as Stokoe (1960) did in order to develop a compositional notational system, does not prove that this structure has cognitive reality. By pointing out that the compositional structure is obvious from a bodily or articulatory point of view, does not help either because we are not discussing anatomy here, but (cognitive) phonology.

The strongest evidence for compositionality lies in the notion of **well-formedness**. Native signers have intuitions about the well-formedness of signs, analogous to the kind of knowledge that speakers of English have and which tells them that /bnik/ is not well-formed, whereas /blik/ is, even though both are absent from the English lexicon. Such knowledge is incompatible with the claim that all the forms are simply listed as holistic units. Knowledge of the list would tell one what is not in it, but not what could not be in it.

For speech, additional knowledge comes from **speech errors** which we also find in signing (Klima and Bellugi 1979). Whether such data support the phonological decomposition up to the finest details, is questionable, so the possibility that this fine structure only exist in the mind of the phonologist who proposes it, remains a real one. However, when such proposals make sense of the array of, for example distinctive handshapes, and replaces a brute force listing of them by an elegant analysis, based on a small set of primitives that follow from general categorization principles, we believe the analysis must be preferred over brute force listing. Listing should be a last resort. **Language acquisition** data also may support the compositional structure that we put forward. we refer to van der Hulst (1996a) for some support of this kind for the structure that was have proposed for handshape. Acquisitional data are, however, notoriously difficult to interpret, especially when we focus on the very early stages.

A further source of confirmation of compositionality in the phonology of speech usually comes from phonological process or rules that make reference to a whole class of signs in terms of a property, or set of properties that they share. Unfortunately, signs language do not provide us with abundant evidence of this sort. Why is that? Phonological rules account for distributional regularities in polysyllabic units, involving assimilation at syllable boundaries, or phenomena like vowel harmony. The pervasive monosyllabicity of sign languages explains the absence of such rules. Another role of phonological rules is to account for alternations in the shape of morphemes that are due to the environment that they occur in. This phenomenon requires word-formation, that is a significant distinction between the domain of the morpheme and the domain of the word, especially in the form of inflectional paradigms. In sign languages, morphology is rather restricted and most words are essentially single morphemes.

To be sure there is a rich verbal morphology (see Supalla 1982, Wallin 1994, Brentari 1999), but here the morphology consist of inserting handshapes, and location features in general **verbal templates** that are underspecified with respect to that kind of information. This kind of morphology is **non-concatenative**, and in can be used to

support the broader aspects of the compositional structure (that is the split in major class nodes). Noun to verb **conversion** (Supalla and Newport 1978) can also be found, again in terms on non-concatenative changes, here of the movement. Still other morphological processes involve **durational modification** of the initial phase or final phase of the sign. Most **concatenative morphology** is compoundlike, and processes *do* apply here, causing reduction of the metrically weaker compound member. However, there do not seem to be general rules, or processes that are sufficiently understood at this point, to strongly argue for the finer details of one compositional structure over the other. In addition, some of these processes may simply be part of the phonetic implementation. Bound affixes are rare and extensive reports on their existence in the literature is even rarer.

The mere fact that evidence for the fine details of phonological compositionality is hard to come by, may, of course, partly be a result of the fact the study of morphology and **allomorphy** has only recently began. Much of the available evidence bearing on the issues discussed in this section can be found in Brentari (1998).

5.2. Cross-linguistic differences

In this section, we wish to draw attention to the fact that the phonologies of different sign languages do not seem to differ so much, and discuss the reason(s) why this might be so.

One of the really interesting areas of the phonology of speech concerns cross-linguistic differences. Studies of syllable structure (if not dealing with one language) typically focus on trying to account for invariant patterns along with a set of parameters that account for quite striking differences. Below the level of the syllables, languages in addition differ in fascinating ways in their inventory of phonemes.

The student of sign language, looking for similar spectacular **cross-linguistic differences** is bound to be disappointed.[18] Again we must be aware of the fact that this can simply be a result of the current state of the field. We cannot really say that many sign languages have been thoroughly investigated from a phonological (or any other) point of view. Under the rubric of 'phonology', in most cases we are dealing with fairly taxonomic phonetic descriptions. By saying this, we do not wish to downplay the fundamental importance of those analytic efforts. Obviously, such work is necessary and it has to come first. We simply need to set the next steps in order to acquire insight into the phonological structure of the languages.

The phonology/phonetics of American Sign Language (ASL) has certainly been studied extensively and this has brought forward a number of important generalizations. Some of these concern the structure of two-handed signs. It has been observed, for example, that if both hands actively move, their handshapes must be identical (Battison 1978). This sounds like an important constraint, but it is not a parameter for cross-

[18] The dynamic lexical phonology is not so clearly present, as we saw in the previous section, while post-lexical phonology (as phonetic implementation) is poorly studied. In both domains, we do not expect to find much cross-linguistic differences. In the first domain because there is not much to differ and in the second domain because post-lexical effects tend to be similar across language to begin with because they are close to natural tendencies ruling production and perception. The study of post-lexical, prosodic phonology of sign languages is still very limited; see Wilbur 1990, to appear, Miller 1996, Sandler (in press), Sandler and Nespor (in press).

linguistic differences. No sign language to date has been reported to violate this **symmetry constraint**.[19]

Also, we do not really see that sign languages differ in important ways in their inventory of possible syllables, or constellations of phonological primes. In all descriptions, pretty much the same handshapes show up, the same movements etc. Differences may in most cases very well be due to the limited scope of the description, covering only a small portion of the lexicon.

Suppose then, that the phonologies of sign languages really do not differ so much. Why is that so, and does it make the study of sign phonology less important? we would like to suggest the following reason for the high degree of cross-linguistic identity; see Newport and Supalla (in press) for a very similar line of reasoning.

Most spoken languages have a large time depth. As far as we know, these languages have been around for a long time, being carried over from generation to generation in sometimes rather stable speech communities.[20] The phonology of languages tends to be affected by the phonetic tendencies present in the implementation system, which, at some point, 'seep' into the lexical phonological system in the form of dynamic operations that account for allomorphy or of changes in the basic **phonotactics**. Often such lexical reflexes of the phonetic tendencies become **unnatural** in drifting further and further away from the phonetic tendencies in which they are rooted. It seems to be essentially unpredictable why and when a certain tendency is thus **phonologized**. Sometimes, analogical forces will try to expel the phonological reflexes that cause allomorphy from the lexicon, but often they stay for long periods of time with surprising stability. As such, they have to be learned and memorized during the long period that children are exposed to extensive language input.[21] Over time, languages come to differ quite dramatically in the patterns and alternations that they incorporate in their lexical phonology.

The situation in the acquisition of sign languages is rather different, and, we will argue, in some ways comparable to the process of **creolization**. In most cases (90%?), deaf children are born from hearing parents. These parents, in almost all cases, do not sign when the baby is born, nor do they learn to sign well enough, or early enough, in order to communicate with the deaf child in real sign language. Often, then, deaf children do not get proper sign language input until they go to a deaf institute where they can mix with their peers and deaf teachers. Even though this may happen very early, the process of language acquisition starts directly after birth (if not before that time). It seems reasonable to believe that a child that starts acquiring sign language in an environment that offers insufficient input, will have to 'make up' a great deal of the language, being guided, no doubt, by the innate abilities that underlie the linguistic capacity of our

[19] The explanation, we believe, lies in the cognitive universal that there is only one articulator in language; see footnote 33. we also wish to point out that the symmetry condition has been systematically observed in gesturing (see Van der Gijn, Kita and van der Hulst 1998, to appear). This can be taken in two directions. Either we conclude that the symmetry condition is not linguistic, but must be attributed to a higher cognitive level (that covers both language and gesturing), or we say that gesturing belongs to language. Perhaps both views do not really differ that much. Either way, language (in the narrow sense) and gesture are closely linked.

[20] This statement ignores processes of language birth (pidgins and creoles) and language death.

[21] Contrary to the popular believe, and without downplaying the incredible wonder of language acquisition, we believe that hours of daily language interaction for 3 or 4 years, and beyond, is a lot.

species. In some sense, then, sign languages are essentially *recreated* by each subsequent generation, and thus they lack the time depth that is characteristic of spoken languages. This also means that there is also less time for any phonetic tendencies to seep into the lexicon and drift away from their natural and unmarked status.

In this sense, sign languages are like creole languages, which likewise often have a narrow time depth and which receive many of their properties in the process of language acquisition, the process in which incomplete pidgins are turned into full-fledged creole languages. Probably, the signing abilities of hearing parents of deaf children (no matter how sincere they try) are not much more elaborate than restricted pidgin languages. When their signing abilities improve this is probably more due to learning from the emerging signing of the child, than to their own efforts to acquire the language in the classroom or from videotapes and books. The phonologies of sign languages are so similar, then, for the same reason that the phonologies of creole languages are similar.[22]

Newport and Suppalla (in press) also draw attention to the following fact. Sign languages presumably emerge and develop within the phonetic space that is more or less similar to the space made up by all the **gestures** that we use. This gesture space is limited to movements and handshape that are presumably **iconic** in one way or another. Apart from that, it is reasonable to suspect that the choice of new sign forms is driven by iconic forces anyway. When trying to 'make up' a sign, it much more difficult to be arbitrary than to target an iconic form. Hence it follows, that different sign languages will be constructed from a pool of phonetic events that is limited. Speech on the other hand is not driven so much by iconic forces, and this makes the choice of speech forms much more arbitrary. Hence we expect spoken languages to differ more wildly.

A further effect, we believe, may derive from the fact that sign languages have no accepted and widely used written form. Many spoken languages do, and we know that writing has a conserving effect on phonologies, including their arbitrary aspects. It stimulates keeping phonologies 'unnatural' and protects alternations from being leveled out by **analogical forces**.

5.3 Iconicity

This section discusses the effect that iconic forces have on the phonology of sign languages. In the spoken languages, arbitrariness of form vis-à-vis meaning is certainly pervasive, and some would say, a defining characteristic of human language, essentially causing *dual patterning*. There is, to be sure, a lot of motivation in the vocabularies of most languages (resulting from **sound imitation**), but one has to look for it, or be made 'aware' of it. True, some language turn out to have pretty sophisticated system of sound symbolism, but sound symbolism is not necessarily iconic. When we turn to sign languages, however, we see that iconicity of form (**form imitation**) is extremely pervasive. Sign languages can much more easily appeal to iconicity because many of the things that we talk about have a physical form or are physical events, and even abstract concepts can mostly be (culturally) linked metaphorically to physical things (for example *love* can be linked to the *heart*).

[22] Sign languages have been reported to differ somewhat in basic word order; see Newport and Supalla (in press)

The problem with iconicity is that its demands seem in conflict with the demands of phonological compositionality because compositionality is based on having a limited list of *discrete* (**digital**) building blocks and combination rules, while iconicity is based on having holistic and essentially *non-discrete* (**analog**) forms that represent a concept or meaning. In this section, following van der Kooij (in prep.), we wish to argue that the phenomenon of iconicity can quite easily lead to an undesirable increase of phonological building blocks. So how do we account for iconicity without increasing the set of building blocks beyond control.

The reason why features that have been proposed in the literature are so extensive, and the related reason why it seems difficult to find minimal pairs for all, or even most of them, seems to be that many phonetic distinctions that are really due to iconicity have been taken to point to distinctions that are potentially contrastive. One cannot, on the other, hand simply ignore iconic properties because they are obligatory and thus must somehow be encoded in their lexical representation. The proposal that is adopted here is that iconic properties are represented as **lexically specified phonetic implementation**.

Iconicity determines specific phonetic properties of signs that interfere with the phonetic implementation system which contains phonetic default rules, based on (ease of) articulation and (ease of) perception. Being lexically specified, iconic-phonetic **prespecification** takes precedence over the phonetic implementation rules in the implementation component.[23] This insight can function as a powerful tool to reduce the number of features in the analysis of sign languages, as proposed in Kooij (in prep.).[24]

I will illustrate this point with reference to place distinctions (van der Hulst and van der Kooij 1998). we focus on the location *chest* as the place of articulation. The lexicon of presumably all sign languages contains a large number of signs that are made (with or without contact) on a variety of specific places on the chest. In most models, every different physical location on the chest that is attested seems to lead to postulating a separate feature, resulting in a large set of features that subcategorize the major class feature [chest].[25] If all these loci are truly distinctive, we would expect minimal pairs that prove their distinctivity, which are, however, typically hard to find. We claim that there is, in fact, only one phonological feature [chest] and that the specific phonetic realizations

[23] Iconicity bears on the relationship between a form and 'something else'. In this sense, it can be compared to **analogy,** as pointed out in van der Kooij (in prep.). In the case of analogy the 'something else' is another form, but in the case of iconicity the 'something else' is 'meaning'. In other words, iconicity involves a correspondence between a form and its meaning, rather than between two forms that have the same meaning. Thus in both cases (that is analogy and iconicity) the form - meaning relationship is involved.

[24] A rudimentary form of these proposals is discussed in van der Hulst and van der Kooij (1998). Van der Kooij (in prep.) also discusses features of handshape and movement.

[25] The use of setting distinctions allows for some variation, but we actually suspect that setting features (being part of the sign's syllabic organization) are not lexically contrastive.

of this feature are determined by phonetic implementation rules involving ease of articulation, perception and, crucially, iconic prespecification.

Thus, iconicity overrules phonetic default. The proposal here is that the iconic information must be represented in the lexicon in order to derive its 'bleeding' effect. Whether signs are iconic or not is, after all, an idiosyncratic property of signs. Is it also idiosyncratic precisely in what way a sign is iconic. As with other idiosyncratic lexical properties, such phonetic factors can disappear in historical processes. Also, it is no co-incidence that iconic properties are prominently present in lexical innovation where we deal with non-systematic, non-rule driven extension of the lexicon. All these considerations support the idea of placing the phonetic iconically-driven factors in the lexicon.

The advantages of the proposed strategy are important and, we believe, worth pursuing. When iconicity is 'stripped away' and accounted for in the lexicon, the phonology becomes, so to speak, manageable. We can end up with a reduced set of features which can be derived from the same kinds of principles that have guided work in features for spoken language, a model, in other words, that displays a binary logic RcvP proposes for the feature set of spoken language.

This proposal raises obvious issues with respect to the notion of distinctiveness and using distinctiveness as a criterion for phonological status. This is especially so since under the present proposal two signs can be phonologically identical, while they differ in their phonetic realization because one is iconic and the other not. We are willing to accept this consequence of the proposed account of iconicity, but at the same time we are aware of the fact that we have opened the door to simply phonetically pre-specify *all* signs in the lexicon, leaving their phonological representation uncompositional, and thus effectively absent. In some sense, perhaps, the phonology of sign truly balances on the edge between a compositional and a non-compositional phonology.

6. Summary and conclusions

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